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The Algorithms

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Abstract: The cultural transmissions of a society like famous paintings, popular music, good poetry, and enduring religious rituals/doctrines/texts serve as mediums for the embodiment of algorithms that interact with the mind and body in looping, mostly unconscious interactions that are mutually beneficial to the participants of the society and the algorithms themselves. Useful algorithms are also found in the mind and bodies of other people, and individuals in a group can be used to outsource specialized tasks to benefit the society as a whole. Since useful algorithms must be embodied in a medium to work, there are physical limitations to the computations that can be performed in our universe.

Keywords: art; poetry; music; algorithms; consciousness

What Is Culture?

The highly valued cultural transmissions of a population like famous paintings, music, poetry, theater, stories, idioms, and religious rituals are not strictly subjective and have objective qualities that can be identified and studied. Hidden in valued cultural transmissions are common symbols, ideas, and rituals that span transmissional domains and function to inspire, remind, and motivate the participants in that culture about behaviors that are conducive to human flourishing. Culture provides a place for information about survival to be stored outside of the body – in inanimate and animate objects, thereby greatly enhancing our cognitional abilities without demand on bodily energy and resources.

Other species have culture too. An intelligent species can think and imagine- run mental simulations of events with information obtained through learning and instinct and then to act in accordance with a reasonable outcome. Culture is the learned system of an organism's environment and includes rituals and social structures, language, song, art, music, institutions, laws, writings, past times and play, fashion and adornments, morals, devices, technology, education systems, religious institutions, government, hunting and food gathering strategies, navigation routes, aggression tactics, and tool use. Culture equips intelligent animals with the thinking tools they need to successfully navigate their lives.

Learned behaviors can influence the genes that are successful in populations and drive divergence and evolution. A well studies example in human cultures is the evolved persistence of lactose digestion. Evidence suggests that humans first incorporated the consumption of animal milk into their diets and then evolved the ability to better digest that milk, showing a cultural influence on genetic inheritance [1,2]. Another example of how culture can influence genes is the adaptions seen in sea nomadic people. The Bajau sea-nomads of Southeast Asia have been living on the water and free diving for food for hundreds of years and their spleens have been increasing in size because of their nomadic sea fairing lifestyles [3]. The increase in spleen size allows for the storage of more oxygenated blood cells and gives then the ability to hunt for food underwater for up to five minutes at a time. The long-lasting pastoral cultures of certain groups and the long-lasting sea nomadic culture of the Bajau people have been shaping their genotypes and phenotypes to better equip them in their niche. Culture and the body are co-evolving. Learned group traditions and norms influence the genes that are selected for and the genes, in turn, influence the cultural norms and preferences. Culture plays an important role in experimentation and niche development, where diversity between cultures in a species can serve as a survival advantage for that species in a changing environment.

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Culture has been documented in whales and the whale culture-gene connection is revealing interesting information about how genes and culture interact and coevolve [4–7]. The cultural transmissions of whales and dolphins and other intelligent animals are limited by body-to-body transmission like clicks or squeaks in whales between mother and calf or visual demonstrations between members of the group. This is limited compared to humans because we can go beyond body-to-body transmission and transmit across thousands of years by inventing writing, drawing, painting, building, and sculpting. By storing information outside of bodies, the information can be stored for long periods of time and in multiple copies and this gives humans a huge advantage over other species when it comes to the transmittance, storage, and retrieval of information. Like humans, the cultural transmissions of other species can also have an influence on the selection of genes, body parts, and preferences for that species. Cultural norms in whale species can cause genetic drift and reproductive isolation, and they can cause adaptive evolution as well. Killer whales can be divided by ecotypes based on food preference like salmon eaters, mammal eaters, and shark eaters. The hunting strategies are learned behaviors passed down from mother to calf and there are genetic differences between ecotypes that reflect the cultural norms of that ecotype. Mammal eating killer whales are larger than the fish-eating kind and they have stronger and more robust mouth parts and metabolic genes that favor a mammalian diet [4–6]. They are also less gregarious than their fish-eating counterparts as to not scare off prey [4]. Their quieter nature may be a totally learned behavior, but their body parts and metabolism show the influence of their culture for selecting for genes that are better equipped for their particular cultural niche. The salmon eating whales are smaller than the mammal eating whales and they do not exhibit the metabolic and bodily adaptions that benefit a strictly mammalian diet. These examples show that like humans, the learned behaviors of other animals can influence the selection of genes that benefit the members of that culture toward their particular cultural norms.

Cultural transmissions have value – they store information about how to succeed at life in particular environment for a particular organism. Culture serves as a motivational and memory tool, that exists outside of the body, but still interacts with the body with the aim of enhancing human flourishing. The important, life enhancing symbolisms that exists within the cultural domains of art, poetry, religion, architecture, and music can be connected to our emotional brain networks – where the symbol is represented to some degree. The information is transmitted (visual image from a painting or auditory sounds from heard poetry, for example) and received by the pre-organized brain and can trigger feelings like joy, fear, arousal, and anger. The symbols and the feelings they inspire can act as a mnemonic tools and motivational devices – reminding us of and driving us toward (or away) the things that enhance or destroy human flourishing.

Two common symbols that show up throughout human cultures and throughout various cultural domains are the horse and the fish. These symbols can be seen embodied in paintings, poems, stories, idioms, religious rituals, and songs to name a few domains. Both animals have been very important to the well-being and flourishing of human beings. The horse provides transportation, strength, power, military advantage, work assistance; and the fish is a good source of protein and harbors one of the only sources of the essential fatty acid, docosahexaenoic acid (DHA), which makes up 10 -20 % of the brain's fatty acid composition [8,9]. These animals are widely embodied in our cultural iconography and rituals.

The symbols distributed and embodied in cultural space act as algorithms – mathematically describable constructs that advocate for their own reconstruction and maintenance. Useful cultural artifacts and rituals that inspire feelings of joy, love and awe are valued. Many would agree that Leonardo da Vinci's horse drawings are beautiful, and they are agreeably highly valued. These algorithms help us by outsourcing materials and storage outside our bodies and we help them by constructing, maintaining and caring for them.

Like whales, chimpanzees have learned behaviors and culture too and the cultural transmissions that have been seen in chimpanzees include tool use, grooming strategies, courtship tactics, food foraging ideas, protection tactics, and war tactics [10]. These are learned behaviors and differ between chimpanzee communities, but the overall goals are conserved like grooming, food finding, etc. Again,

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unlike humans, the cultural transmissions of other animals are restricted to oral/visual transmissions between members of the community and mother to offspring. Carving, drawing, painting, and then writing transcend the body-to-body knowledge barrier. There are cave wall drawings of horses from 25,000 years ago that can still inspire awe and joy and act as a reminder of the horse, a very useful friend to humans. We have countless written texts of instructions and stories preserved over centuries that allow for even a hermit to know and benefit from the collection of human knowledge with little direct human interaction.

An algorithm is a mathematical construct of the parts of a physical system that can steer energy and resources toward its own ultimate replication/maintenance (self-preservation). We carefully preserve and copy valuable art, poetry, texts, rituals, buildings, and music and those constructs help us by storing information and resources outside of the body. Modern computers run on algorithms as well, and they are embodied in binary units in the medium of silicone and electrons. Like drawing, painting, and writing, coding in silicon stores information outside the body allowing for humans to live more efficient, successful, and prosperous lives. The bits of code in silicon within computers provide a powerful medium for algorithm storage because great amounts of information can be stored in very small transistors and their networks.

Within the human brain are algorithms too – stored in neurons and their network are the memories, lying dormant and waiting to be recalled. If I asked you to close your eyes and recall the shoes you were wearing today, that image that you see is a representation from your brain. It is stored in your brain, like the 1s and 0s are stored in on/off networks of transistors in computers. And like computer programs, memories can be recalled with the right impetus. Along with memories, preorganized symbols relevant to human flourishing also lie dormant in unconsciously processible networks, waiting to be recalled with the right impetus. These preorganized symbols are connected to the emotional system, and when triggered, motivate and steer humans toward or away from objects and scenarios that increase or decrease human flourishing without conscious deliberation.

One well studied example of unconscious preorganized processing is with the snake symbol. The snake symbol is found throughout many religions, stories, poetry, language, and artworks. The first etchings made by Homo sapiens 75,000 years ago and etchings made by other hominin species including Homo neanderthalensis and Homo naledi resemble the cross-hatch patterns seen on the backs of the most venomous snakes [11–13]. Studies have shown that human subjects that are shown images of snakes will react to the snake visual in ways that, at least at first, bypass conscious pathways [14,15]. Many humans are very afraid of snakes without ever having had a single negative snake encounter or any snake encounter [16]. The snake has a long history with humans and our ape ancestors, spanning millions of years, and the snake has been and remains one of humanities greatest threats. Studies suggest that the snake's elongated shape [17], diamond shaped scale patterns [18,19], and movements have become etched into the neuronal circuits of primates' brains. This pre-organized framework is linked to visual circuitry and can quickly be triggered to incite attention, movement, and changes in the body like increased heart rate and freezing that bypass conscious thought or control. Visual masking experiments [15,20], experiments on pulvinar neurons [21], and experiments on human infants [22] corroborate the idea that the symbol of the snake is embedded in our preorganized unconscious minds as a useful catalyst to move us quickly out of danger and away from one of our greatest and most enduring threats. Without learning, the idea of the snake is already present and lying dormant in the pre-organized human mind.

Many pre-organized symbols make up our unconscious minds and interact with environmental cues that are linked to fear and reward networks and can cause attention and movement beyond conscious processing. Studies done using continuous flash suppression, where an image is shown to a test subject in short pulsing flashes alongside another image which makes it impossible to consciously process the test image, show that people are unconsciously drawn to attractive human faces [23]. Without having any knowledge of why a particular selection is chosen, humans will unconsciously choose faces that they later deemed more attractive. They are attracted to a beautiful thing, having no conscious awareness of having been attracted to that thing, showing that just like

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the pre-organized snake symbols ability to unconsciously repulse/deter, other pre-organized symbols can attract/draw.

Sometimes the symbols embodied in cultural artifacts that have value for flourishing are indirectly linked to the important life enhancing resource or action. For example, many cultures over large amounts of time have incorporated the beetle symbol in their religious iconography, fashion, art, and hobbies. The scarab beetle in ancient Egypt was worshipped as the embodiment of a sun god [24]. In Japan beetles are kept as pets and ancient Samurai helmets were sometimes shaped like beetle horns. Beetles are a popular collecting item and hobby for many people throughout the world, and many people are dazzled and interested when observing the many colors and shapes of beetles. What do beetles have to do with human flourishing? Beetles are an attractive and delicious target for good sized fish, and fish provide protein and the essential fatty acid, DHA, which is almost only found in fish. They also come in a variety of colors which is useful for attracting a variety of fish, or for when fish have become used to a particular bait and changing color can catch then off guard. Beetles can also be dried and stored for use at a later time. A peoples' pastimes, play, religions, fashions, and art are infused with symbols that keep us near and reminded of the things we need as humans to live optimized lives. There is no conscious understanding of the value of many of these symbols; they function by stimulating our feelings, not our thoughts.

What Is Consciousness?

Many of the cultural artifacts work by triggering our emotional systems and bypassing conscious understanding or awareness. We react to the stimuli, either moving away from or towards objects and scenarios, without awareness of what we are doing or why we are doing it. All that matters is it feels a certain way – either pleasant or unpleasant, and our bodies react appropriately. These reactions are unconscious, and not accessible for conscious deliberation; we have no knowledge or memory of what transpired or why it affected us.

There is a condition some people have called blindsight that can be caused by certain kinds of brain damage that result in blindness [25]. Even though they are blind, people with blindsight can still react in non-random ways to stimuli. They can move away from or towards objects and scenarios in beneficial ways but are not conscious of doing so – they have no memory of the event, they are blind. When asked why they raised their arms to block objects in non-random and successful ways, they don't know why other than experiencing a feeling to do so. People with blindsight can navigate the world in successful ways without being conscious of what they are doing, so what is the point of being conscious anyway?

For people with blindsight there is no memory of the event that took place. There is no memory, nothing to recall and conjure later to mull over and learn lessons from. These people are only reacting to stimuli and cannot remember the circumstances and the environment so they can update their priors and make better decisions or inform others of potential dangers or rewards through complex communication. Without a memory, they cannot imagine and simulate alternative outcomes through logic and reason by accessing their memories and making new connections. Strings of complex language would be impossible to understand. Other than one-word descriptions or simple phrases, without a conscious "I" to act as a placeholder to process words, hold them in a string, and recall them to memory and imagination, complex language and communication would not be possible. Abstractions in instruction, arbitration, mediation, calculations, reading, and learning would not be possible. Consciousness is memory of experiences and objects. It is the placeholder "I" that remembers, imagines, reasons, explains, communicates complex ideas, performs complex calculations, teaches, reads, and learns. Unconscious processing just reacts, it can do none of the things just mentioned.

Without consciousness, we are mere zombies like the blindsighted, reacting to the world without memory, understanding, processing, moral lesson learning, ability to warn others and teach/explain, communicate danger/reward, troubleshooting, reasoning, or planning. Consciousness gives an edge to human flourishing by allowing for complex abstractions that enable vicarious lesson learning and minimizes the life-damaging mistakes that individuals who are wholly unconscious will make more of.

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These ideas parallel System 1 and System 2 cognition as described by Kahneman [26] where the two major styles of thinking and information processing include a "fast" System 1 mode that is unconscious, involuntary, cheap, intuitive, low-energy, lazy, and sometimes good enough; and a "slow" System 2 mode which is the conscious, energy-demanding, attention requiring, effortful evocation of the "I" that recalls, place-holds, directs and routes information, and calculates solutions. System 1 is automatic, outside of our control, and comes from born intuition/biases and/or learned/mastered processes. We have to work and expend energy to rationalize (use system 2 thinking) and check the solutions that "freewheeling" system 1 quickly produces sometimes incorrect answers for.

In Kahneman's model consciousness is costly. It takes effort and energy to fight against system 1 impulses and biases and even though the answers to real world problems may not be sufficiently correct, many people function predominantly in system 1 thinking anyway. These people do not make rational decisions and their solutions can be riddled with errors and inconsistencies and they may be biased and bigoted. Their energy expenditures are lower (or they may be more energy depleted) than those who take the time to analyze and weigh the evidence and to calculate the solutions and check for inconsistencies and ultimately change their minds if need be. Consciousness (to conjure the placeholder "I") allows us to make better decisions, find truer outcomes/better solutions - but it comes with an energy cost that some people can't fully afford. It is costly to be conscious and Kahneman offers a method to measure consciousness: more cognitively demanding tasks require energy and effort which manifests in increased pupil dilation and heartrate. He also describes how energy depletion can affect decision making and how people who are depleted by mental and physical exertion will often make poorer choices because they don't have the energy supply to conjure the "I" that can check and validate their decisions. People who function through mostly system 1 thinking are often sleep-walking through life and are relying on lazy and low-energy biases and intuition, which often leads to poor decision making and incorrect answers and a decrease in the quality of life.

The Algorithms

The symbols found in cultural space must ultimately transmit information to the brain by sights and sounds, and then be received by the brain and processed. The symbols are preserved in the way that the parts of the medium are put together; be it, shapes painted, words spoken, music produced, rituals performed, structures built or molded, transistors connected, and even neurons connected in other peoples' brains.

These symbols must have a physical embodiment and follow physical laws. They can be described by mathematical abstractions, and the media that the information travels-by, like light and sound waves, can be described by mathematical descriptions too. The way the parts are put together store and then transmit information and that information is preserved as it moves through mediums. It is in the brain that the algorithm is processed and moves us in life enhancing directions and in directions that encourage us to preserve, care for, reproduce, nurture, repair, rebuild, remold, reperform, and repeat the algorithms. Then again, they inspire and guide us, and again, we nurture and replicate them. These mind-culture looping interactions extend the mind into the environment, forming a coupled system, an idea that was starting to be developed by Clarke and Chalmers in their "extended mind" thesis [27]. These looping interactions outsource cognition outside the body and into many mediums and instantiations, decreasing cognitive load by acting as an external memory. Individuals who knew where to find outsourced knowledge (in computers) are more likely to forget the knowledge they know they can obtain from an external source and more likely to be able to recall something that will not be available from an external source [28]. The tools and art of a culture can greatly expand and extend and stretch the mind beyond the body and by outsourcing cognition to culture and society, the ability of a person to know things and do things and succeed at life is magnified.

An algorithm is a mathematical construct of the parts of a physical system that can do things while embodied in that system. And the things they do, if they are successful algorithms, are to advocate for their own replication and maintenance. Physically, the algorithms steer resources and energy towards their own self-preservation, and this can be imagined better when considering the

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DNA-protein relationship, which is an algorithmic relationship that has no intercepting mind. When interacting through minds, it is by helping us that they help themselves, whether it is reminding us to eat nutritious foods, inspiring us to adopt helpful animals, or calculating solutions to real world problems. The algorithms act as keys that unlock a benefit or reward and a particular algorithm can be embodied in many mediums. The cherry fruit is filled with anti-inflammatories and antioxidants and cherries are a ubiquitous symbols found across mediums including rituals, paintings, idioms, and poetry.

Algorithms are embodied- they are represented in physical form in the materials of the world such as neuronal patterns, air molecule distributions, silicon placement, paint pigment placement, metal or wood distributions, and other materials and combinations of materials. Because they are made of materials that require energy and time/resources to produce and maintain, economically conservative algorithms outcompete more wasteful varieties - if they get the job done, which is to transmit information in a good enough way with limited unwanted consequences. The power of an algorithm lies in its ability to inspire, remind, and calculate. In general, that is proportional to the number of instantiations of that symbol and the time those symbols last in the medium. Due to energetic considerations, algorithms that can do the same job but require less resources will be favored. Although compression and coarse graining bring economic benefits, they also come with potential costs. Coarse graining and compression may cause the message to become too distorted to be received efficiently, or coarse graining may lead to too many bugs: alternative side-programs not intended or wanted with wasteful and negative consequences. Because many of the symbols embedded in cultural artifacts work by triggering our unconscious-feeling pathways, the outcomes are often just "good enough" and better solutions with less negative outcomes that are more rational and less wasteful may not be obtained. But the economic benefits of culture ultimately outweigh some of the negative side-effects: the energetic/time/storage benefits outweigh the bugs/side-effects/negative outcomes. Ultimately the best solution is to make the unconscious conscious and to tease apart the value of these symbols and rituals so that we may keep, enhance, and promote the parts that are conducive to a flourishing life and dispose of the parts that are the bugs: the side programs not intended that have a negative influence on human flourishing.

Not only are useful algorithms found throughout cultural domains, but they are also found in the neuronal networks of other peoples' brains. We are social animals, and as such we have evolved to work together in social networks, and we rely on one another for optimized lives. Within societies, specialized tasks taken on by certain individuals in acts of cooperation decrease cognitive and physical workloads and demands and can benefit the group as a whole. Just as calculators, musical instruments, and weapons have outsourced tasks to tools outside the body, individuals in groups can also be used to outsource specialized tasks. Mathematical and musical geniuses, artists, warriors, hunters, farmers, healers, and fisherman are a few groups of people whose talent many of us depend on to live optimized lives. These jobs can be learned by many, sometimes with great effort, but there are people who are born with these potentialities, desires, and instincts. For these individuals the groundwork has already been laid and the neural networks already coded, at least to some degree. As social animals we depend on the brains and bodies of others so that we can live optimized lives, together.

We can explore the hidden algorithms found in the brains of mathematical, musical, and artistic savants by teasing apart their contributions and trying to uncover their value and meaning. Savants like Ramanujan, Euler, Mozart, Blake, and Leonardo Da Vinci seemed to possess divinely inspired talent- producing masterpieces of beauty, emotion, and awe in near effortless fashion at times. With little training and resources and sometimes under harsh and adverse conditions, these geniuses produced lasting works of extreme value that have stood the test of time. Sometimes relying heavily on System 1, they were able to produce works of quality that could not be matched by even the most well trained, hardworking students of mathematics, music, and art. Within their brains, in the patterns of connections of their neurons, lie powerful algorithms that they were born with in part. Like the inherent fear of snakes preprogrammed in most humans, these individuals' brains are preprogrammed and primed to do their function. With few cues and triggers and with the right opportunities and resources, they produced some of the most important human cultural artifacts ever

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produced like useful mathematical equations, masterpieces of art and sculpture, inspirational poetry, and transcendental music.

Both Euler and Ramanujan were considered master mathematicians and geniuses of their domain, contributing prolifically to their fields with almost divine like powers they produced theorems nearly effortlessly where it would be impossible for others to do or it would require a lot more time, energy, and System 2 like cognition/tools. Ramanujan grew up in rural village in India and had access to very few texts and resources and Euler suffered from eye problems and eventually became blind. These issues did not hamper their genius, they thrived despite adversity and lack of resources. Ramanujan would credit his discoveries to the goddess Nimaigeri who he said would reveal the equations in a flash of insight. If we tease apart their contributions and try to uncover their value and meaning we see that both Euler and Ramanujan, and many other talented mathematicians/engineers, were discovering and working with equations that calculate the solutions to the same problems: like the value of pi or a set of prime numbers. The number pi and prime numbers are a big fascination for mathematicians and number theorists. And they have huge practical applications in many domains including architecture, engineering, and music.

Because nature's algorithms are made of raw materials that require energy and time/resources to produce and maintain, economically conservative algorithms that get the job done will outcompete less compressed forms. When Ramanujan claimed that the goddess had given him a function (infinite series) that could represent all primes, he was ultimately proven wrong. The infinite series function he produced was very good at predicting primes, but it was false in some circumstance. His algorithm was coarse grained to some degree - it had some bugs, some alternative outcomes, some logical inconstancies. Therefore, it could not be proven, but it was a very good algorithm for producing primes, and in terms of human flourishing, that is all that matters. So how could humanity practically benefit from knowing a series of primes? By allowing for the production of efficient machines; specifically, geared machines including chariots, waterwheels, clocks, celestial monitors, calculators, computers, and other wheeled devices. Engineering different prime numbers of teeth on the cogs of geared machines forces the gears to interreact evenly so that the same teeth, with their small imperfections, do not interact with each other more than with the other teeth. This ensures that small internal flaws are smoothed out over time, rather than amplified (if you use nonprimes). This enhances the efficiency, lifetime, and power of the machine while decreasing the torque and loss of energy to heat. Primes ensure that the precision and the accuracy of geared machines lasts longer while minimizing energy loss and optimizing efficiency.

Practical applications of the irrational number pi are numerous is scope and range and are used in multiple domains including architecture, engineering, and signal processing. Calculations of pi to several digits are necessary in the building of arches, bridges, columns, buildings, ands towers. Pi is also necessary for the measuring the sinuosity of rivers, the revolutions of a wheel, and the capacity of storage tanks. Pi is needed when calculating the area of a circle and the volume of circular vessels. The practical applications of pi are many and far reaching, and calculations and equations that compute pi have held the fascination of mathematicians and number theorists for millennia. Both Ramanujan and Euler were interested in calculations of pi and the fastest algorithm we have today to calculate pi (to many millions of digits) is based on Ramanujan's infinite series for pi. Calculating pi to several digits is important in the precision of measurements, and making measurements with precision can bring benefit to a group of people. For example, the invention of barrels allowed ancient civilizations to flourish as wooden storage barrels could be used to store and transport many kinds of goods including water, wine, foods, and ammunition for periods of time. The cylindrical shape of the barrel provides uniform stress distribution and strength to the vessel and lack of corners and limited edges allow for easier cleaning and maintenance. Oak barrels enhance the taste of wine and allowed for the easy transposition (can be rolled, floated, or stacked) which opened the door to ancient commerce across the Mediterranean and beyond. Essential water, wine, food, ammunition, gold, and many other things could be packed and transported in barrels for commerce and the precision by which one could calculate the cubic volume of these goods depended on the measurements of the barrel – and the precision of the measurement of pi. Civilizations that could

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calculate pi to several digits made fewer negatively impacting mistakes in measurements, had sounder buildings and structures, and collected more of the monies that they were owed through commerce.

Music

Music is a powerful cultural artifact that activates our emotional networks in a form of unconscious communication. Music is a quick and effective way to organize groups and communicate a range of emotions and it has many uses in society including cultural adhesion/unity/loyalty (many nations have an anthem), storytelling/information distribution, call-to-arms, meditation/calming, catharsis/emotional release, motivation/inspiration, warning, longing, courtship, maintenance of social and pair bonds, propaganda, and ritual. Music speaks to our emotions and the pleasure it can induce is a powerful magnet that can organize and draw people together and keep them coming back for more. Whether it be played and/or sung in churches, concerts, political gatherings, or other gatherings, these gatherings provide opportunities for the kinds of interactions that contribute to human flourishing. The joy, pleasure, bodily movements, and togetherness that music incites is a catalyst for the kinds of behaviors that have benefitted humans for a long time - like sex, partnership, friendship, community, and allyship.

It is interesting to note that many talented mathematicians like Euler and Leibniz and even the fabled Pythagoras had interests in the mathematical applications to music and musical theory. Before the mathematical brain was commandeered for architectural, engineering, and accounting/commerce practicalities, it may have had its roots in musical harmony extraction and musical device building. Mathematical concepts of interest to talented mathematicians like prime numbers, pi, exponential functions, imaginary numbers, and sine and cosine waves also have their uses in musical harmony theory. Pleasurable music must be organized and limited to a ratio of frequencies and a musical composer must set the tone. Prime numbers serve as a basis for musical tonality and the engineering of instruments that can accomplish these tonalities [29,30]. Euler's identity, an algorithm discovered by Euler and considered the most beautiful equation by many math enthusiasts and mathematicians, is also a powerful shortcut for the extraction of pitches and chord progressions from sound intensity signals. Even though there are many orders of magnitude of ways of playing three or four notes on a musical device to form a chord progression, only a few of these are pleasurable and frequently observed in the music found throughout cultures. There are only so many ways that notes can be put together to sound harmonious to the human ear, and Euler's identity provides a way of extracting information from pleasurable music so that the notes can be copied and the music replicated [31]. The mathematical brain may have evolved with the purpose of musical contributions and then later the algorithms could have been outsourced for use in other kinds of problems and tasks like machine building and signal- processing.

A way of gaging the temporal dimensions of the culture-mind coevolution is by looking at the time of onset of musical instrument invention to the time of the emergence of the musical savant. Savants like Mozart and Argerich, and many others, are seemingly born with talent and the ability to play the piano and other instruments. From about five years old both Mozart and Argerich could move their fingers over piano keys and play notes in ways that seemed miraculous and/or divinely inspired to most others. This would not be possible for most people or only possible after many years of training. The abilities of these savants have been imprinted through mind-culture coevolution over many generations after the advent of the keyboard instrument. The first keyed instrument was a wind instrument that emerged out of Alexandria in approximately 300 BC [32] and then spread quickly throughout Greece and Rome and eventually became the precursor for the very ubiquitous church organ. Church organs are powerful and moving instruments that draw people into the pulpits and keep them coming back to the church week after week. Good organ and keyboard players are respected, revered – and rewarded. Their families flourish – their genes spread. These individuals bring us pleasure and, just we still do today, we reward talented musicians in ways that enhance their lives too. In looping interactions, they scratch our back, and we scratch theirs.

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Religion

Religion is a cultural artifact whose rituals, iconography, art, music, texts, and mandates function to remind, motivate, and steer individuals towards behaviors that are conducive to human flourishing. Because these transmissions happen mostly unconsciously and develop over time, the behaviors that religions direct may be outdated for the current times and can therefore sometimes produce undesirable, wasteful, or negative consequences. Also, because religious traditions are subject to coarse graining and are often just good enough to get the job done, undue suffering can manifest for individuals and outside groups.

Despite the bugs, there is value in religious transmissions, and common symbols, ideas, and rituals can be found throughout the world's religions both past and present. From the ancient religions of Egyptians, Sumerians, Greeks, Romans, Pagans, Native Americans, and Africans to current day Buddhism, Hinduism, Judaism, Christianity, and Islam – the religions that endured were rife with symbolism conducive to cultural flourishing. Embedded in these religious traditions are common rituals, texts, iconography (gods and goddesses) and symbols that guide the participants in areas like accounting and record keeping, notation and writing, surveying and architecture, vessel design and usage, useful animals, fire-making/starting/upkeep, fluid and water sources, food sources and nutritional food kinds, building and furniture making materials, weapon making and materials, clothing/ fabrics materials and resources, pest-control strategies and resources, transportation, law-and-order, nursing/healing/child-care, midwifery, love/care and forgiveness, sex, family unity, medicinal sources, safe-environments, warfare, hunting, and funerary strategies.

Some of the most ubiquitous symbols found throughout many of the world's religions, past and present include fish, olive trees, and the fig trees. These foods have been essential to the success and proliferation of the cultures that have incorporated them into their belief systems in the forms of stories/myths, mandates, iconography, art, and ritual. These foods provide humans with essential nutrients that are linked to increased health, fertility, and longevity; and decreased disease, morbidity, and sterility. Cultures that have incorporated these symbols into their belief systems have endured by not only providing their participants with the nutrients they need to form optimized bodies to survive and thrive, but also minds that can appreciate the value of these symbols in terms of an emotional response to their "beauty". These symbols are good examples of human mind/culture coevolution.

Besides some sources of algae, fish is one of the only sources of the essential nutrient Docosahexaenoic acid (DHA) and fish symbolism is not only found throughout poetry, literature, music, and art – both past and present, but its symbolism is also found throughout many of the world's religions in the form of texts, art, iconography, mandates, and ritual. From gods and goddesses of fish to stories, symbolism, and mandates, almost every religion that has endured has incorporated the fish symbol extensively in its tradition [33–35]. DHA is a highly polyunsaturated fatty acids that makes up a significant portion of the grey matter of the adult human brain and DHA deficiency has been linked to a myriad of diseases including poor mental health, fatigue, low life span, neurodegenerative diseases, skin diseases, eye disorders, heart disease, and other disorders [36–41].

The fig tree is the oldest cultivated plant with evidence of its cultivation starting 11,000 years ago - predating grain cultivation by over 1000 years [42,43]. Fig tree symbolism is not only ubiquitous throughout the world's most enduring religions and myths both past and present, but it is also very ancient – spanning back to the inception of record keeping and incorporated into the earliest religious iconography. From before 4000 years ago, many cultures have incorporated fig tree symbolism into their belief systems as the use and cultivation of fig trees spread throughout ancient Mesopotamia, Egypt, Syria, Israel, Greece, Iran, Asia, Africa, and the Americas. Important ancient Egyptian goddesses, some of whom were worshipped for thousands of years, including Isis, Hathor, and Nut had myths and iconography heavily steeped in fig tree symbolism, mythology, and worship [44]. The fig tree was scared to ancient and enduring Greek deities like Demeter and Dionysus [45] and sometimes incorporated into scared rituals like the Dionysian Mysteries – which lasted over 1500 years. Fig tree symbolism and mythology was present during the rise of the Roman empire, when the founding deities, Romulus and Remus were shaded and protected beneath a scared fig tree when

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left at the banks of a river to die [46]. One of the most important symbols in Buddhist philosophy is the sacred fig tree, the Bodhi Tree, whose offshoot trees are still the sites of religious pilgrimages and whose original location was described as the site in which the Buddha gained enlightenment sitting beneath its shade over 2500 years ago [47]. The fig tree also plays an ancient, central, and enduring role in Hindu iconography, mythology, and ritual, where parts of the tree represent the influential deities Brahma the creator as its roots, Vishnu the protector as its trunk, and Shiva the destroyer as its leaves. Hindus center yoga and meditative practices around the fig tree and both Hindus and Jains practice meditation under the tree. Figs trees are mentioned in the Hebrew Bible where Adam and Eve cover themselves with the leaves of the fig tree after eating from the tree of knowledge [48]. The Old Testament also describes the promised land to the Jewish people as one that is overflowing with fig trees [49]. Both the Old and the New Testament have parables and proverbs including fig trees as a symbol of wealth, independence, freedom, prosperity, abundance, and fear [50,51]. Figs are one of the only fruits mentioned in the Quran and described as beneficial to eat by the prophet Mohammed. One of the verses in the Quran is named after the fig and begins with a divine devotion to the fig [52]. A sacred fig tree is a central component of the nearly 2000-year-old enduring Kikuya culture of Kenya in East Africa, where fig trees are considered children of god and rituals and prayers are performed under the tree in hopes of prosperity and fertility. Wood from the tree is used as kindling during rituals and events like building of a new home [53].

Studies show that figs are loaded with essential vitamins, nutrients, minerals, phytochemicals, antioxidants, and anti-inflammatories [54–57]. Figs are high in calcium, magnesium, vitamin A, potassium, low-glycemic carbohydrates, and can have up to seventeen different amino acids. They have a lot of fiber and show anti-constipation benefits, while also providing a low-glycemic form of sugar and modulating diabetic symptoms in a positive way – like enhancing glucose clearance and tolerance and improving insulin utilization [58,59]. Many studies on animals and humans show a broad spectrum of health and medicinal benefits with fig consumption, including improvements in conditions like diabetes, cancer [60,61], inflammation [62–64], parasitic infection [65], fungal infection [66], gut ailments, cognition, [67] and cardiovascular disease [68]. Figs are rich in polyphenols and flavonoids, which decrease lipid peroxidation by scavenging free radicals. Lipid peroxidation is a leading cause of inflammation and one of the causes of cancer [69–71].

The olive tree is also one of the first cultivated fruits, with evidence appearing of its cultivation from 7000 years ago in the Levant region [43]. Like fig symbolism, olive symbolism is ubiquitous throughout the world's religions past and present; and its incorporation into cultural belief systems parallels its path of cultivation and spread throughout the world. Olive symbolism is found in ancient Sumerian, ancient Egyptian, ancient Greek, ancient Roman, Jewish, Christian, and Islamic religious iconography, myth, and doctrine.

Olive oil is composed of over 70% monounsaturated fatty acids, most of which is oleic acid [72], and consumption of olive oil has been linked to 19% lower cardiovascular disease, 17% lower cancer, 30% lower neurodegenerative diseases, and 18% lower respiratory diseases [73]. Consumption of oleic acid has been shown to increase the monounsaturated to polyunsaturated lipid ratio in cells [74] and polyunsaturated lipids are the major target for lipid peroxidation, which is the leading cause of inflammation. Cardiovascular disease [75], neurodegenerative diseases [76], cancer [77], and lung disease [78] are linked to chronic inflammation, which can cause cell death [79]. Peroxidized lipids can also further break down to reactive aldehyde electrophiles that can move to DNA locations and react with nucleotides causing mutations and cancer [69]. Monounsaturated fatty acids do not form peroxidation adducts as readily as polyunsaturated fatty acids, which can resonate and better stabilize the radical intermediate that peroxidation reactions must go through. It is worth noting that palm oil, which is also rich in oleic acid (up to 40 % [72], also has strong symbolic representation throughout the world's religions including Judaism, Christianity, Islam, Buddhism, Hinduism, and many African religions. Palm symbolism was also heavily represented in the ancient religions of Mesopotamia, Egypt, Greece, and Rome. Studies have shown that a diet rich in palm oil has anti-diabetic, anti-thrombotic, anti-inflammatory, and cardiovascular benefits [80–82].

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Cedar trees and the related cypress tree are another kind of tree whose symbolism is found spread throughout many religious rituals, texts, and iconography in the ancient past and the present [83–85]. The cedar tree is mentioned dozens of times in the bible [85] and cedar and cypress tree symbolism can be found in the paintings of the most highly valued artists including Sargent, Klimt, Turner, van Gogh, Dali, Magritte, Leonardo, and Signac. Both kinds of trees belong to the same family of trees whose wood is rot and termite resistant, long lasting, water repellant, easy to work, and has minimal shrinkage [86]. These kinds of wood are highly valued, even today, and are often the preferred materials for boats, roof shingles, log cabins, and outdoor furniture. Native Americans and ancient Europeans/Mediterraneans made their boats and canoes from cedar and cypress and these cultures also incorporated the trees into their religious iconography and rituals. Due to their water-resistant qualities and long durability, these trees were an incredibly valuable resource to many human cultures, and they were often worshipped and incorporated into those cultures' belief systems.

The average human adult body is composed of approximately 60% water by weight. Clean water is an essential resource, and the human body cannot go longer than a couple days without water before it dies. Most of the water that humans in the world consume both past and present comes from groundwater sources like rivers and lakes. No other deity is more heavily represented in the human pantheon of divinities than those of the river and water deities [87]. Dirty, contaminated rivers and lakes are a leading cause of disease and death in human societies [88–91]. Many illnesses and diseases from pathogens or chemicals in polluted rivers and lakes kill large numbers of children and adults every year.

Without clean fluids the human body has no chance of survival. As populations grew around major rivers, so did water pollution. Alternatives to fluids were needed to ensure survival. Beer was the first cultivated grain and evidence of beer consumption can be found as far back as 10,000 years ago along the Yangtze River in China [92]. The process of fermentation and distillation and the antiseptic properties of alcohol (alcohol destroys bacterial and pathogenic cell membranes) provided humans with non-contaminated fluids. Although alcohol has been linked to many diseases and is also a leading cause of death [93,94], in the context of having a choice between pathogenically contaminated water sources or alcoholic beverages, those who chose alcoholic beverages had a better chance at survival. There is evidence for selection for alcohol addiction as alcoholism runs in families [95–97], can be induced in animals through artificial breeding and selection [98–100], and common gene variants have been identified throughout populations [101–104] in people with alcohol use disorders. Some of these genetic variants have been linked to genes related to impulse control, anxiety management, and reward pathways. There are also many religious rituals and iconography including gods and goddesses related to beer, wine, and spirits. The spatial and temporal locations of alcohol related religious iconography parallel the locations were large civilizations lived along major rivers including China, Mesopotamia, Greece, Egypt, Rome, and India providing further credence to the notion that alcoholism evolved as a survival strategy in environments with poor water sanitation. Some of these alcohol related deities include Li Bai, Liu Ling, and Du Kang of China; Suduri, Siris, and Ninkasi of Mesopotamia; Ash, Bes, Nephthys, and Tenenet of Egypt; Bacchus and Liber of Rome, Acratopotes, Amphictyonis, Dionysus, Methe, Oenotropae, and Silenus, of Greece; and Varuni of India.

As humans found ways to sanitize water though processes like boiling, and as humans began to cultivate and use drinks like tea, where boiled water is used as the major source of fluids, alcohol no longer became the better choice in terms of chances at survival. The use of tea dates back a few thousand years and there is evidence of tea use at just over 2000 years ago [105,106]. With the onset and the widespread use of tea (and advent of boiling water) in places like Asia, came the onset and spread of other gene variants that deterred alcoholism like mutations in the ethanol metabolic processes that increase aldehyde levels and induce nausea and revulsion. Humans have as a remnant of our evolutionary past, where it was not uncommon to come upon fermented fruits and alcohol, genes that can metabolize alcohol like the alcohol dehydrogenase gene (ADH) and the aldehyde dehydrogenase gene (ALDH). Both can be found altered in mostly Asian populations to increase the levels of aldehyde in the body which can induce revulsion of alcohol and prevent alcoholism [107,108]. In the metabolism of alcohol, alcohol is first converted to acetaldehyde by ADH and then further oxidized to acetate by ALDH. The kinds of mutilations found throughout Asian populations

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either speed up the functioning of ADH to increase the concentration of nausea inducing acetaldehyde or greatly speed down the functioning of ALDH, which also increases the concentration of acetaldehyde. Sometimes both kinds of mutations are present. The increase of acetaldehyde is protective against alcoholism, but this comes at a cost. Acetaldehyde is a reactive aldehyde and can react with DNA to cause mutations and cancer. People who drink too much alcohol and people who have the alcohol flush genes but drink anyway are at risk of getting cancer by having high concentrations of carcinogenic aldehydes in their system [109]. Tea has caffeine, and there is evidence that caffeine addiction may have been selected for as well [110–112]. Common phenotypes and genes that are linked to caffeine processing, enjoyment, and seeking run in families and may play a role in keeping humans drinking hot beverages whose water has been boiled thereby reducing the probability of contamination in fluids and replacing the need for alcohol. The increase in tea drinking paralleled the rise in tea rituals found in several cultures and religions including Buddhism, Hinduism, and Islam. The advent of boiling water and tea preparation made alcohol consumption superfluous, and some religious mandates emerged forbidding alcohol consumption as a sin.

Other cultural rituals that encourage the drinking of tea and hot or boiled water include mandates described in some forms of alternative medicine like those found in Chinese and Indian traditions. Traditional medicine is much like religion, in that these behaviors are induced by mostly emotive responses that are largely unconscious. The feelings that hot water and tea consumption are healthy and healing drive the participants towards those behaviors and in the case of hot water and tea consumption those behaviors are largely innocuous and perhaps beneficial, but behaviors inspired by traditional healing beliefs can be incredibly dangerous too. Modern medicine is based on the scientific method which is a mostly conscious endeavor where the reasons behind phenomena are expressed and evaluated, and corrections and updates are made as new evidence is presented. Like religious rituals and mandates, traditional medicine may work sometimes but not for the reasons that you think, and the transmissions are mostly unconscious and develop over time and can be outdated or dangerous. Better evidence-based medicine applications may be available, and just like relying on religion in directing and steering human life, traditional medicine beliefs and behaviors may lead to undue suffering, death, and waste.

Symbols in Language

Much of language relies on conscious communication, where words are strung together in sequence to convey a meaning to a recipient that is meant to be taken literally from the words in the string. Each word depends on the context of the words in the sentence and the mind of both the sender and the receiver needs to access memory stores and represent the words in sequence to convey and understand the meaning. But hidden within conscious communication there are unconsciously communicated symbols that are relevant to human flourishing and are conveyed in phrases such as idioms whose expressions have nonliteral meanings. The phrase making up the idiom has some cultural meaning, but the words in sequence are meaningless in terms of being taken literally. These idioms express a sentiment, but they are also often a form of unconscious communication. By harboring meaningful symbols in their expressions, idioms can remind and inspire senders and receivers of the objects and behaviors that are important for human flourishing.

There are many idioms in English and other languages including French, Portuguese, German Hindi, Romanian, Swedish, Italian, Spanish, Arabic, Chinese, Japanese, Greek, and Turkish that use cat symbolism to convey some culturally expressive meaning. There are many cat idioms in the English language that are used frequently to convey different sentiments whose literal meanings can be ridiculous [113]. Some of these include: “don’t let the cat out of the bag” to mean don’t tell a secret; “cat’s got your tongue” to mean a person who is not responding; “scaredy-cat” for a fearful person; “when the cat away, the mice will play” for having fun in the absence of authority; “look what the cat dragged in” to describe a disheveled person; “a copycat” describes a person who imitates another; “it’s raining cats and dogs” describes severe weather; “cat and mouse game” describes a pursuing relationship. And there are many more. There are also many cat idioms in other languages and some of them parallel the English phrases in meaning and construct while others are different in construct

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and meaning. In Swedish the phrase "at night all cats are grey", means that the subject doesn't really matter. In Hindi the phrase "after eating 900 rats, the cat goes on a religious pilgrimage" is used to describe an evil hypocrite who absolves a life of sin with a single virtuous act. In Arabic, the phrase "I remember, and the cat comes and jumps" refers to a coincidental incident. In Chinese the phrase "the cat and mouse are sleeping together" refers to conspirators who are doing evil. In Japanese the phrase "like casting gold before a cat" describes wasteful behavior. The Greeks say the "sleeping cats cannot catch mice" as a description of a lazy person. The Italian phrase "to have a cat to skin" means to have a difficult task ahead. These are just some of the cat idioms found in other languages, and like English, other languages have many cat idioms.

The cat is a much-loved pet that can be found in many American households and households throughout the world. The cat is also the number one predator of rodents and top controller of rodent populations [114,115]. Rodents are a major cause for the spreading of human diseases and the death of human beings [116]. Rodents flourish in cities with large human populations, and they can transmit many diseases to humans and between humans and have been implicated as one of the causes for the spread and continuation of many devastating and life destroying diseases over many centuries across the globe. Cats are a cultural phenomenon, both past and present, and they have been associated with numerous gods and goddess and been incorporated in many legends, myths, and religious stories. Cat odors are a natural deterrent to rodents [117] and cats can catch and kill many rodents and they have been used in rodent management to protect food supplies and keep rodents away from households, organizations, food storage facilities, and major cities. Cultures and minds that have incorporated cat symbolism have been successful at managing their disease loads and over time cat affinity has been shaped into many humans' minds. By evoking the cat in daily language, we strengthen cultural ties and remind one anther of what is important.

The crab apple, the ancestor of the modern domesticated apple, is native to Asia and North America and was domesticated in Kazakhstan during the neolithic approximately 10000-4000 years ago [118]. Since its domestication and spread, the apple has influenced the culture of the people who have cultivated and consumed it. Apples are a favorite object for painting and drawing and many of the world's most valued artwork have apple symbolism incorporated in them. Apple symbolism is also rife in the religions of the societies that grew apple trees for consumption. Apples are incorporated into the rituals and myths of the Asians, Celts, Greeks, Romans, Persians, Native Americans, French, Spanish, Turks, Levantines; and apple idioms are in use from those regions today. In Greek the phrase "an apple of discord" refers to a desired object that is coveted by two people. In Farsi, the phrase "like an apple cut in half" refers to two objects that are very similar. In French a small person can be referred to as "high as three apples". In English we say "the apple does not fall fer from the tree" to mean a person behaves like their parents, or "the apple of my eye" to describe a thing we love dearly [119]. In Turkish, "if you never taste a bad apple, you will not appreciate a good one" means to appreciate success one should experience failure. Some of the same idioms are found in several languages like "an apple a day keeps the doctor away" is used in English and Italian.

Apple rinds and flesh are filled with polyphenols and antioxidants and other health enhancing molecules [120] and scientific research has shown that apples are effective at decreasing the probability of certain cancers and are beneficial for decreasing the symptoms of heart disease, diabetes, inflammation, asthma, and cognition issues [121–126]. Apples are easy to store and carry and they provide a good source of glucose along with vitamin C, potassium, and a form of fiber that has been shown to be beneficial for healthy gut flora and for nutrient absorption [127–128]. The healthy attributes of apples have benefitted the societies that have consumed them and have helped shape those societies' cultural domains.

The horse is one of the oldest and most represented symbols in Paleolithic cave drawings and sculpture starting approximately 25,000 years ago [129,130]. Most Paleolithic cave depictions are of the horse [131]. From over 100,000 years ago, horses were abundant throughout Europe and Asia and there is evidence that both Neanderthals (from 55,000 years ago) and Cro Magnon (from 33,000 years ago) hunted and ate horses. Horse meat is nutritious and is filled essential vitamins, minerals, amino acids, and fatty acids [132]. Horse meat keeps longer and is more digestible than other kinds of meat

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like sheep or beef. Horse milk is also superior to cow milk in terms of nutrition and digestibility and it, along with horse flesh, is rich in the fatty acid, alpha-linolenic acid, which is an essential fatty acid very important to the development of human bodies and to the maintenance of human health. It has been argued [132] that the reason why the steppe region was abundant in horse symbolism was not because the horse was the main important caloric source (there were more abundant sources of intake) but rather because equids are one of the only sources of the essential important fatty acid, alpha linolenic acid, which is otherwise only found in water or woodland environments.

Horses have been hunted since the Paleolithic, but the first evidence of domestication came from the Botai culture of Kazakhstan from 3500 BC. The shape of the horses' bodies, tooth wear, and milk and fat deposits show that the first horses were domesticated for food and milk consumption [133]. Most modern-day horses can be traced back to another independent domestication event 2300 years ago in the steppe regions of Russia as part of the Sintashta culture [134]. This domestication event was driven by warfare amongst competing steppe societies and led to the adaptations seen in modern day horses including increased load bearing of the back, more docile mood, and higher endurance. The domestication of horses during this time and their use in warfare was paralleled with the use of chariots and increased metallurgy. The horse descendants of this domestication event quickly spread throughout Europe, Asia, and Anatolia. Horses gave great advantage to the societies that used them in battle, and they were a huge factor in the success and dominance of many cultures including the Sumerians, Persians, Mongols, Islam, Europeans, Greeks, French, Americans, Native Americans, Japanese, and Polish to name a few. The use of horseback riding, chariot pulling, mounted archery, and supply and ammunition transportation made the horse an essential contributor to the success of many modern societies. Horses gave these cultures success over their opponents and consequently shaped the minds of the people in those cultures toward affinity for horses and the desire to be near horses, ride them, symbolize them, and mythologize them.

The horse is a very popular symbol found throughout cultures and represented in many cultural transmission mediums including art, religion, toys, stories, and language. Many people have a great affinity for horses and many adults and children love horses and want to ride horses, play imaginary horse games or play with horse toys, hear horse stories, and draw horses and unicorns. The horse is a good example of how culture can shape the minds and preferences of people in terms of what they find pleasing or what they desire to be near. Horses are a common subject in the English idioms [135] of many of the cultures that have benefitted from them. The English language is filled with horse and horse-related symbolism. Sometimes the horse is mentioned directly in phrases like "as healthy as a horse", "get off your high horse", "hold your horses", or "I could eat a horse". Sometimes horse-related symbols are represented instead like "to chomp at the bit", "get back in the saddle", or "loosen the reigns".

There are other symbols that are frequently represented in common idioms that are important to human flourishing including water, dog, wheel, barrel, fish, and tree. The same sorts of hidden symbols that are found in common idioms are also found in other cultural transmissions like art, music, religion, and poetry. Poetry is also a form of unconscious communication and like idioms, poetic verses that move us are filled with important symbolism that is related to human flourishing. Many of the most valued and famous poems and poets, across the globe and past and present, have tapped into our unconscious emotional systems by using phrases and words that have value in human lives. Like idioms or some song lyrics, a sequence of words in a poem may not have literal meaning, or may sound fantastical or ridiculous, but hidden within the verse of great poems are secret gems that unlock parts of our minds to inspire, motivate, and remind us of what is important.

Robert Frost was one of the most valued poets of his time and won four Pulitzer Prizes and was poet laureate of the state of Vermont and nominated for a Nobel Prize in literature 31 times. He has been described by critics and fans as not just one of the greatest American poets but also one of the greatest poets of all time. Below in his poem "After Apple Picking", which is an allusion to coming to the end of life, Frost uses apple symbolism to convey the feelings of exhaustion that come with the end of life. The ladder, a useful device, is positioned in the tree. The barrel, a vessel for storage, lies empty beside it. In this poem Frost uses symbolism important for human flourishing, but the values

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of these symbols are conveyed unconsciously, and the reader may feel the emotional resonance but is only aware of the metaphor for end-of-life exhaustion.

After Apple Picking (public domain)

My long two-pointed ladder's sticking through a tree
Toward heaven still,
And there's a barrel that I didn't fill
Beside it, and there may be two or three
Apples I didn't pick upon some bough.
But I am done with apple-picking now.
Essence of winter sleep is on the night,
The scent of apples: I am drowsing off.
I cannot rub the strangeness from my sight
I got from looking through a pane of glass
I skimmed this morning from the drinking trough
And held against the world of hoary grass.
It melted, and I let it fall and break.
But I was well
Upon my way to sleep before it fell,
And I could tell
What form my dreaming was about to take.
Magnified apples appear and disappear,
Stem end and blossom end,
And every fleck of russet showing clear.
My instep arch not only keeps the ache,
It keeps the pressure of a ladder-round.
I feel the ladder sway as the boughs bend.
And I keep hearing from the cellar bin
The rumbling sound
Of load on load of apples coming in.
For I have had too much
Of apple-picking: I am overtired
Of the great harvest I myself desired.
There were ten thousand thousand fruit to touch,
Cherish in hand, lift down, and not let fall.
For all
That struck the earth,
No matter if not bruised or spiked with stubble,
Went surely to the cider-apple heap
As of no worth.
One can see what will trouble
This sleep of mine, whatever sleep it is.
Were he not gone,

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The woodchuck could say whether it's like his
Long sleep, as I describe its coming on,
Or just some human sleep.

Another of Frost's poem, "The Silken Tent", is one of his most popular, but unlike "After Apple Picking", the allusion to what he is talking about is less clear. A woman is compared to a silken tent, with a central cedar pole, held together by ropes and cord, with references to love and thought and compassion - a compass holding together the world. Unlike "After Apple Picking", the metaphor in "The Silken Tent" is harder to grasp, but the feelings it incites have nevertheless made it one of Frost's most popular poems. This poem is filled with important symbolism such as: a tent (shelter), ropes (useful tools), cedar (a durable wood), a compass (an important architectural and engineering device), and woman (a very important central pillar of the family and society).

The Silken Tent (public domain)

She is as in a field of silken tent
At midday when the sunny summer breeze
Has dried the dew and all its ropes relent,
So that in guys it gently sways at ease,
And its supporting central cedar pole,
That is its pinnacle to heavenward
And signifies the sureness of the soul,
Seems to owe naught to any single cord,
But strictly held by none, is loosely bound
By countless silken ties of love and thought
To every thing on earth the compass round,
And only by one's going slightly taut
In the capriciousness of summer air
Is of the slightlest bondage made aware.

"The Day I Saw Lu Yu off to Pick Tea" is an ancient Chinese Tea poem written by the poet Lu Yu's friend, Huangu Zeng, around 750 CE [136]. Like some other ancient tea poetry, this poem is still popular today. This poem evokes a feeling many can relate to when saying goodbye to a friend, but it also harbors important symbolism. Some of those symbols include: tea, an important source of fluids; mountains, an important source of safety and resources; a temple, a place for comradery and connection; a candle, a source of light; a fountain, a source of water; springtime and blossoms, a time for connection after the winter. The poem is also about friendship, which is an important resource for human flourishing, and it also reminds the reader about the value of solitude and thought, also important for a good life. The poem reminds us of the importance of past ages and traditions. This poem has stood the test of time and has been preserved and copied for generations, and by uncovering its symbolic value, it can be understood as to why. Li Bai is another Chinese poet from the 8th century who is still considered one of the greatest romantic poets ever, and whose life has taken on a mythological aspect from his legacy of timeless poetry centered mostly around drinking alcohol.

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Bring in the Wine

Don't you see me?
The waters of the Yellow River have come up from the sky,
They run into the sea and never return;
Don't you see me?
The bright mirror in the high hall has sad white hair,
The morning is like blue silk and the evening is like snow.
Be proud to live life in thorough enjoyment,
Don't let the golden cup stand empty against the moon.
My talents are destined to be useful,
Come back after all the money is gone.
Cooking sheep and slaughtering cows is fun.
Drink three hundred cups at a time.
Master Cen, Dan Qiusheng,
Drink wine, Don't stop drinking.
A song for you- please listen to me.
Bells, drums, delicacies and jade are not valuable.
I hope I never awake from my drunken existence.
All the sages in ancient times were lonely and forgotten,
Only the drinker leaves a name.
In the old days, King Chen had a banquet.
There was a lot of fun and drinking.
Why does the master say that he has less money?
It's up to you to decide what to sell.
Five-flowered horses,
Thousands of coins worth of fur,
Let the boy exchange them for fine wine,
Together with you, we will sell off eternal sorrow.

- *Li Bai. (my translation)*

William Butler Yeats was an Irish poet and is considered one of the greatest poets of all time and earned many accolades both during his life and posthumously. Yeats mixed mythology with his poetry and his poetry had Greek, Pagan, and Christian influences. "The Song of Wandering Aengus" tells of the search for a love that got away, and Yeats uses fish and apple imagery as an allusion to tell the story of catching and losing love and searching for that love while sampling from what life has to offer. The poem is filled with important symbolism starting with the hazel woods (a useful wood material), to useful activities like making a fishing pole and fishing. Important foods are mentioned like berries (which have antioxidants), apples, and fish; and fluids are described as a stream of water, The trout is silver, and the apples are silver and gold, and these are useful metals and the materials of tools, devices, jewelry, weapons, and art. Yeats mentions tending a fire by blowing on it. The narrator of the poem is wandering and walking over lands and hills – useful behaviors when searching for food, territory, or mates. The story itself reminds the reader to pursue love and not give up, but to continue living during that pursuit. There are valuable lessons,

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reminders, symbols, and behaviors relevant to human flourishing in this poem that speak to our emotional and feeling systems but much of it would go unnoticed by our conscious minds.

The Song of Wandering Aengus (public domain)

I went out to the hazel wood,
Because a fire was in my head,
And cut and peeled a hazel wand,
And hooked a berry to a thread;
And when white moths were on the wing,
And moth-like stars were flickering out,
I dropped the berry in a stream
And caught a little silver trout.

When I had laid it on the floor
I went to blow the fire a-flame,
But something rustled on the floor,
And someone called me by my name:
It had become a glimmering girl
With apple blossom in her hair
Who called me by my name and ran
And faded through the brightening air.

Though I am old with wandering
Through hollow lands and hilly lands,
I will find out where she has gone,
And kiss her lips and take her hands;
And walk among long dappled grass,
And pluck till time and times are done,
The silver apples of the moon,
The golden apples of the sun.

- *William Butler Yeats*

There are many poems by famous poets that have horses or horse-related themes as a subject matter. “Horses” by Pablo Neruda captures the ecstatic appreciation many of us feel when seeing horses [137]. “Blacksmith Shop” by the Nobel Prize winning Polish poet Czeslaw Milosz, who is also one of the world’s most highly regarded poets, describes the inner workings of a Blacksmith’s shop during the production of a horseshoe. The feeling of being in the well-worn shop, where workers are forging and firing metal as horses wait is represented beautifully in the poem [138]. Japanese poetry, much like Japanese art, has distilled symbols of value down to their most simplified representations. Haiku is short and has few words, but those few words nonetheless convey meaningful information. Below are three horse related poems from Haiku master, Basho:

On the roadside

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A mallow was fated
Eaten by my horse

Horse, clippity clop
A picture of myself
In a summer field

A Winter day
on horseback my shadow
Is frozen

- *Haiku by Basho: (my translation)*

The poetry of a culture represents the values of that culture. Many cultures that have flourished today have done so with the aid of the horse in battle. Below is a poem from the much-revered French poet and writer, Victor Hugo, that captures the mechanical nature of war and killing and the instinct of empathy even in the face of that obligation. The horse is ridden in battle toward an enemy who wants a drink. The empathic soldier offers a drink to the man only to have the man try to shoot him as he gets closer. The soldier feels no offence toward the man that attempted to kill him.

After the Battle

My father, this hero with such a sweet smile,
Followed by a single hustler whom he loved above all
For his great bravery and for his tall stature,
Traveled on horseback, on the evening of a battle,
The field covered with dead people on whom night fell.
It seemed to him that he heard a faint noise in the shadows.
He was a Spaniard from the routed army
Who was dragging himself bloody on the side of the road,
Moaning, broken, livid, and more than half dead.
And who said: "Drink! to drink out of pity! "
My father, moved, handed his faithful housard
A flask of rum hanging from his saddle,
And said: "Here, give this poor wounded man a drink. "
Suddenly, at the moment when the hussar fell
Leaning towards him, the man, a kind of Moor,
Seized a pistol which he was still clutching,
And aims at my father, shouting: "Caramba! "
The shot passed so close that the hat fell
And the horse swerved backwards.
"Give him a drink anyway," said my father.

- *Victor Hugo (my translation)*

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Fashion, Textiles, and Design: The Snake and the Leopard

There is evidence that the architecture of the primate visual system has been heavily influenced by the threats posed by venomous snakes [139]. Snakes remain and have been one of humanities greatest threats, and over millions of years our bodies and minds have been shaped by the threats they pose. Our minds and bodies have evolved to quickly and unconsciously react to venomous snakes and snake symbolism, patterning, and movements can catch and hold our attention [15,18,20–22]. Most venomous snakes have diamond or ogee patterns that serve to warn. The snake benefits by not striking a human because a human (either the person bit or a friend) will likely kill it once it does. They have evolved warning patterns to get our attention and warn us and we have evolved the ability to quickly and unconsciously recognize and act on those patterns. There is a benefit to reminding, instructing, and preparing for snake encounters, and the first recorded symbolic art in humans was likely serpent symbolism represented in cross hatched etchings from 70,000 years ago [11]. Snake symbolism is found throughout the world's cultures and across many cultural domains including religion, painting, sculpting, jewelry, fashion, textiles, design, architecture, stories, language, poetry, songs, and dance.

Snake symbolism is found in the earliest and most primitive religions where the snake can take on many roles, some good, some bad, and sometimes neutral or a mix of good and bad. The symbolism is there to remind us, prepare us, and prime us for when an encounter may happen. As an example, the story of the "fiery flying serpent" in the Tanakh serves as a reminder and warning of venomous serpents. Based on the wording in the Bible, the vipers described are most likely from the saw scaled viper family, a kind of venomous snake that causes the most human deaths. Saw scaled vipers are small, lightning-fast, deadly, jumping, diamond and ogee patterned vipers that are ubiquitous throughout Africa and the Middle East. There are several warning verses in the Bible about dangerous vipers and their burning deadly bites and lighting fast moves, and these serve as direct reminders about their dangers. But there are also other instructions conveyed in less direct ways like when Moses uses a rod to place a bronze serpent as a cure from snake bites. That serves as an indirect reminder of the snake pole which is a good way to subdue, distract, and detract dangerous and fast-moving snakes. The ancient Greek's also incorporated a rod with a snake into their iconography through the god of healing and medicine, Asclepius, who is represented with a staff with intertwined serpent, a symbol that is still used to this day to represent healing and medicine. Staff gods were also represented in the iconography of ancient Andean and Peruvian religions and the first recorded evidence of religion in that region dates back 4000 years ago in the form of an etching of a fanged, serpentine-armed, god holding staffs [140]. These stories and myths (and the art and literature that comes along with them), through direct warnings or symbolic imagery, have resonance and staying power because they are helpful reminders to people about important tasks for living and surviving in snake inhabited environments.

Wherever venomous snakes are found, which is almost everywhere, snake iconography is weaved into the fabric of those cultures. Snake iconography is a common component in many ancient and indigenous religions including African, Greek, Indian, Asian, North American, and South American religions. The shamanic religions of Latin America are filled with snake imagery and some of their rituals, like Ayahuasca consumption, induce hallucinations that are commonly of snakes even in people not native to those cultures. There is a benefit in reminding, instructing, and preparing humans for snake encounters as evidenced by the many human religions, stories, and myths centered around snakes.

Snake iconography is also literally weaved into the fabric of most cultures. Snake patterning can catch and hold our attention and has influenced our preferences in textile and material designs as seen in the popularity of ogee and diamond patterning in fabrics, rugs, wallpaper, tiles, bedcovers, tablecloths, curtains, and etchings. Some of the most highly valued rugs and furniture have incorporated ogee and diamond patterning, and some of the most highly valued brands of handbags including Louis Vuitton, Chanel, Dior, and Gucci exhibit diamond and ogee patterning. Popular and long enduring games like chess, checkers, tic-tac-toe, playing cards, and Snakes and Ladders also have snake imagery and/or diamond or checkered patterning.

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Ogee shapes are popular in Middle Eastern, Indian, and Gothic architecture and design. Ogee arches are common in some of the most admired architecture in these regions and are deemed aesthetically pleasing even though the curvature and the inflection points make them nonfunctional in terms of bearing weight. They are commonly used for decorative purposes only. It is interesting to note that almost all known inhabited Neanderthal caves also bore pointed entrances or interior archways resembling ogee arches and that Neanderthals too made crosshatch etchings [12]. Neanderthals did other advanced tasks too like rope, tool, and glue making so it is possible that they also had incorporated artistic symbolism into their cultures and were using snake symbolism in art and possibly in their religions and myths to remind and prime themselves for snake encounters.

List of known inhabited Neanderthal caves with pointed entrances or interior pointed archways [141–151]:

Hazar Merd Cave, Iraq
Shanidar Cave, Iraq
Chagyrskaya Cave, Russia
Stajnia Cave, Poland
Qafzeh Cave, Israel
Amud Cave, Israel
Apidima Cave, Greece
Gorham's Cave Complex, Gibraltar
Hohlenstein-Stadel Cave, Germany
Do Eshkaft Cave, Iran
Fumane Cave, Italy
Hadzi-Prodan's Cave, Serbia
Hell Cave, Slovenia
Karain Cave, Turkey
Kebara Cave, Israel
Kulna Cave, Czech Republic
Noisetier Cave, France
Okladnikov Cave, Russia
Tabun Cave, Israel
Skhul Cave, Israel

The leopard and lion diverged approximately 2.0 – 3.0 million years ago [152] in Africa at a time and place where our hominid ancestors were still living a somewhat arboreal lifestyle [153]. It was just after this time when our human ancestors became strictly bipedal and started living down from trees. It may have been the predation pressures imposed by leopards which also live an arboreal lifestyle that drove that change as leopards' favorite foods include large primates [154]. Coming down from trees and freeing up our hands to hold sticks and spears could have allowed our ancestors a chance to survive in leopard inhabited environments.

It is not just our bodies but also our minds that have been influenced by leopards. Like snakes, human infants' attention and gaze are held by leopard patterns [22] and early art and ancient and modern religions are rife with leopard symbolism. Leopard print is also commonly found in textiles and materials and seems to have a timeless quality in fashion trends [155]. Like snake patterning, leopard patterns can hold and keep our attention and we surround ourselves with unconscious reminders of one of our greatest predators.

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Outsourcing Tasks: Color Vision and Color Blindness

As social animals we share food within our family units and social groups, and we fight against our enemies together to protect our territory and livelihood. Specialized tasks taken on by certain individuals in acts of cooperation can enhance the kinds of food sources that are available for everyone and/or protect the members of the group overall. Colorblindness is not only a sex-linked trait found in humans but it also a sex-linked trait found in many social primates, specifically those that eat fruits and insects. Because colorblindness is a sex-linked trait and because it is maintained over time in various species and because there are advantages to both trichromatic and dichromatic vision in obtaining food, the evidence shows that colorblindness is an evolved adaptation that benefits the species that it manifests in [156–164]. Studies show marmosets, tamarins, squirrel monkeys, spider monkeys, and capuchins have sustained populations where males are colorblind, and the females have at least some trichromatic vision [156–159]. The studies show that the benefits of trichromatic vision include the ability to see colored fruits and distinguish between colored items, and the benefits of dichromatic vision include the ability to more quickly recognize cryptic or camouflaged prey. Trichromatic individuals have a slower response to cryptic prey because of trichromatic noise and less developed shape and pattern detection [160–163].

Human beings also have sex-linked colorblindness, where on average 8.0% of males are born colorblind and only 0.5% of females are colorblind. Because colorblindness is a sex-linked trait and allows for the division of labor and useful tasks between group members (in this case by sex) and because we are a social and food sharing species that participates in frequent warfare, colorblindness in humans may also be an evolved adaptation that allows for the outsourcing of useful tasks outside of the body. Human males hunt in groups and participate in warfare where camouflaged prey and predators are either hunted or fought. Studies show that colorblindness gives humans an advantage over trichromatic vision in detecting camouflaged or cryptic items [162]. The evidence for colorblindness as an adaption are sustained sex-linkage, homologous animal patterns, and proof of usefulness in cryptic tests. Further evidence that colorblindness in humans is an evolved adaption and not just the relaxation of trichromatic vision that is no longer necessary is that most colorblindness results in not the loss of the m type cone, but the shifting of that cone toward longer wavelengths [164]. As a result, there is a muddying of both red and green color toward the same hue. Rarely does the small wavelength, s type, cone mutate and rarely do the m cone, s cone, or l cone have a loss of function. The directionality of the mutations that result in the majority of colorblindness and the target of one specific cone in a particular direction – that being the diminution of the perception of red and green, the colors of natural environments, lends further credence to the notion that the majority of colorblindness is not the result of the relaxation of color vision, but an evolved adaptation.

Algorithms without an Intercepting Mind

The body can outsource useful algorithms to cultural and social space, thereby freeing up memory demands and cognitive loads, and allowing the body to better streamline and focus resources and energy to other important life sustaining tasks. Environmental algorithms interact with the mind in looping, mutually beneficial relationships where the algorithms help us by acting as memory, calculating, and motivational tools and we help them by building and maintaining them.

The DNA/protein system is an algorithmic system that exists in the absence of an intercepting mind. The sequences in DNA and protein are pieces of code, embodied in their medium, that act as executable programs whose mutually beneficial relationship of looping interactions help build, sustain, and maintain one another. There is no programmer or designer, no intercepting mind or thought. It is simply the forces of chemistry playing out under the right conditions, with the right molecules that sustains this algorithmic partnership. The DNA functions primarily as a copy and read mechanism, where the linear string of nucleotides allows for easy access to replicate the code and read the code; and the protein functions through its three-dimensional shape, which can store the energy needed to carry out the tasks that ultimately get the DNA replicated. They have the same kind of mutually beneficial relationship seen in macroscopic algorithmic systems where they scratch

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each other's backs by outsourcing tasks away from themselves so they can better focus and streamline recourses and energy to their specialized tasks, enhancing the system as a whole.

To efficiently copy the genetic information and to read the information, it is necessary to have access to the information. The information, or code, must be read in sequence and DNA is an excellent molecule for storing and reading the code. However, to replicate the code efficiently and to build and catalyze its formation requires a different kind of molecule – a large three-dimensional molecule that can store catalytic and binding energy in its three-dimensional fold – a property that is very different than the things that a linear molecule like DNA can do. Proteins, on the other hand, are excellent at harvesting energy in a watery milieu to accommodate three dimensional folds that can store catalytic and bonding energy. The DNA stores the information of how to build proteins in sequence and proteins can do the functions that get the DNA replicated and maintained.

RNA is a molecule that has both the functionalities of copying and three-dimensionality but is less efficient at copying than DNA and is less efficient at catalysis/binding than protein. RNA is an ancient molecule and thought to be the precursor of DNA/protein and is a candidate for the precursor molecules at the origin of life. Nearly four billion years on, RNA is still used in living systems and now plays a mediating role between DNA and protein with a small function in code keeping and a small function in catalysis compared to DNA and protein molecules, which have mostly taken over these specialized tasks through outsourcing. It can be imagined that in the future, all traces of RNA in living systems may totally disappear, having had their functions absorbed by other, more efficient molecules that can do specialized tasks. One can also imagine that this might have happened at the very beginning of life on earth too, so that the precursor molecules at life's origins may have been completely replaced by other molecules, with all traces of their existence being outsourced and wiped away.

The Limits of Computation

The continuous outsourcing and feedback of algorithmic systems keeps these systems growing in complexity and functionality by mutually benefiting both the sender and receiver (as long as resources and energy are available- otherwise the system will halt). Modern computers provide a powerful medium for algorithm storage because great amounts of information can be stored in very small transistors that are made of just hundreds to thousands of atoms per transistor which allows for billions of transistors per chip. Vast amounts of executable programs that are conducive to human flourishing can be written in binary code and stored in the circuits of transistors and chips. This is limited by only the number of transistors we can fit on a chip and our ability to access or "read" off the information off that chip. Moore's law has held for a few decades, that is, the number of transistors on a chip has doubled every two years or so, but there are indications that it is slowing down, and we have no reason to believe that if will hold indefinitely. Indeed, because algorithms must be embodied in physical stuff to work, we are limited by the laws of physics as to how small we can program things, how small a distance we can access the information, and how small a distance we can make a measurement; basically, we are limited by how small a distance we can know a thing. And based on our current understanding of physics, we cannot know a thing beyond $1.1616255 \times 10^{-35}$ m, the Plank length.

To read off the information of an algorithm we must be able to probe at that distance and get meaningful output. Any attempts to probe particles beyond the Plank distance would require such high energy collisions that they would produce black holes. Anything beyond the Plank length is too uncertain to measure, and analogously, any time interval beyond the Plank time (the time it takes for light to travel the Plank length = 5.39×10^{-44} s), also cannot be measured. If we could program every atom in the known universe (there are approximately 10^{80} atoms), that would still not be good enough in terms of processing power to solve a 10^{200} digit calculation by brute force in any sort of appreciable time. If we could program every quark (a proton is 10^{-20} m and a quark is 10^{-4} times smaller and there are 44 quarks in carbon for scale), it would still take a very long time to just read off one iteration of the calculation. We are already approaching the Plank length, but if we could further divide the quark into subparticles, the theoretical limit would be hit at $1.1616255 \times 10^{-35}$ m, beyond which we would not be able to read off the information in any currently known reliable way.

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If we could divide atoms and quarks generously (10^{200} particles) and program 10^{20} particles and line then up a Plank length away from each other (1.1616255 X 10^{-35} m), it would take .0001s to go through every iteration of a 10^{20} calculation by brute force on a classical computer. If we could entangle those particles and use a quantum computer, we could achieve an 2^N speedup. A 10^{200} calculation would be too great for even a quantum computer to be useful in polynomial time.

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